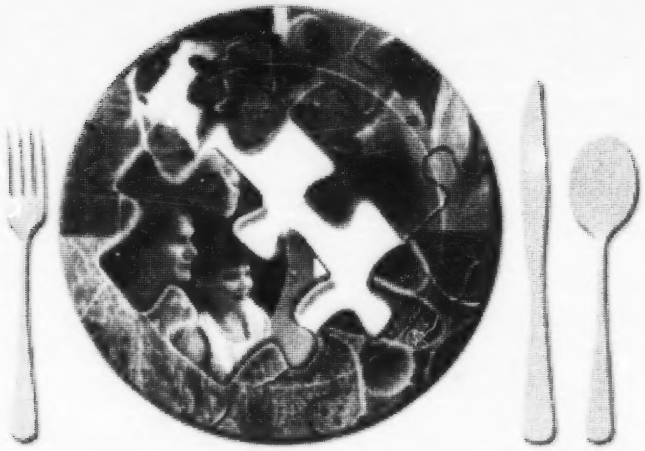

University of Guelph

FOOD PROGRAM
2000 - 2004

Abridged Version of Presentation to the Agricultural Research Institute of Ontario
April 2000

UNIVERSITY of GUELPH
Ontario Ministry of Agriculture, Food and Rural Affairs
SCIENCE, TECHNOLOGY AND PEOPLE

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INTRODUCTION

Program Mission Statement

To undertake research and information transfer to support Ontario food processors in the manufacturing of high quality products that are acceptable to Canadian consumers and competitive in world markets.

The mission statement reflects the Food Program's emphasis on meeting the information and technology needs of Ontario producers and processors to improve competitiveness and sustainability. It also reflects the need to determine the policy, economic, and broader social factors that influence consumer food behaviour in Canada and the acceptability of Canadian food products internationally. Consumers judge food quality and acceptability on the basis of many attributes including sensory (appearance, texture, flavour), nutritional and safety factors.

Program Executive

Valerie Davidson was appointed Food Research Program Director (RPD) in October, 1999. She replaced Marc LeMaguer who was Food RPD from 1996 - 1999. In September, 1999, Marc was seconded to Health Canada as Director General, Food Directorate.

In November 1999, a Food Program Executive Committee was formed with the following members:

Dr. Valerie Davidson, Food RPD, School of Engineering
Dr. Rickey Yada, Chair, Food Science (CFSM)
Dr. Bruce Holub, Human Biology and Nutritional Science (HNRU)
Dr. Judy Sheeshka, Family Relations & Applied Nutrition (CRI)
Dr. Heidi Schraft, Food Science (CFRIS)

The Executive Committee includes representation from the major departments which have current research projects in the Food Program. Kemptville College is the only satellite campus with current research projects and communication is directly between the RPD and Mr. Bill Curnoe, Director, Kemptville College. Committee members are also active researchers in strategic research units at the University of Guelph including: Canadian Institute for Research in Food Safety (CRIFS), Centre for Food and Soft Materials (CFSM) and Human Nutraceutical Research Unit (HNRU). The Consumer Research Institute (CRI), a facility for social and food safety communication research, has recently been established to conduct consumer behaviour research as it relates to the entire food production system.

STATE OF THE INDUSTRY

The Ontario food system stretches from agricultural production to food manufacturing and distribution through retail sales and food services. The complete system is extremely important to the Ontario economy in terms of value of shipments and jobs.

Economic Value of Ontario Food System (most recently available statistics)

	Value of Shipments (Year)	Jobs (Year)
Production	$ 6.9 billion (1998)	67,500 farms (1996)
Manufacturing	$ 23.4 billion (1997)	85,700 (1998)
Retail food sales	$ 17.0 billion (1998)	145,600 (1998)
Food services	$ 13.2 billion (1998)	271,800 (1998)

The strategic report of the Ontario Processing Research and Services Committee (January 2000) highlighted some key facts about the food manufacturing sector:

- The Ontario food and beverage sector is **second only to transportation** in terms of its contribution to the Ontario economy.
- GDP from food and beverage industries is 13% of that from all manufacturing industries in Ontario.
- Ontario generates 51.2% of the GDP of the total food and beverage industry in Canada.
- In 1996, Ontario's food industry ranked 5th in North America for capital investment and 8th for value of shipments.
- In 1997, approximately **60% of the total value of shipments** in Ontario was generated by medium-sized industry firms (firms with annual sales between **$10-200 million**), as compared to **large sized firms (31%** of the total value of shipments) and small firms (less than 10% of total value of shipments) .
- 1998 Ontario agri-food exports totalled $6.2 billion ($2.5 billion in 1990). Eighty percent of all exports are now value added, a figure which has increased substantially over the last few years.
- Although the dollar value of Ontario exports has shown steady growth over the past 10 years, the value of imports has also increased ($ 4.5 B 1990 - $ 10 B 1998).

Strong *et al.,* in the 1996 report of the International Development, Research and Policy Task Force (*"Connecting with the World Priorities for Canadian Internationalism in the 21st Century"*) conclude that, as the economic trend towards globalization and knowledge-based industries continues, Canada's ability to compete in various markets will be increasingly dependent on the capacity of our agri-food and biotechnology industries to deliver high quality products for specific markets at competitive prices. Other major exporters, including the USA and European Union, are investing heavily in R&D which is needed to improve quality, add value and reduce costs. Without a commitment of comparable scale, Canada will be relegated to a mere supplier of low-cost commodities, allowing others to capture the more lucrative markets for value-added products.

Evidence that industry has recognized the importance of integrative research is found in the restructuring of such companies as Monsanto, Novartis, AgrEvo, Dupont and DowElanco. These companies have concluded that future success is contingent upon an integrated multidisciplinary approach. This shift is a "strategic repositioning" away from the traditional emphasis on chemical enterprises with some involvement in the life sciences to becoming life science companies whose major focus and source of profit will be in biological or biotechnological activities. In Ontario, where a large portion of agri-food economic activity is generated by medium-sized enterprises, processors need access to a strong research infrastructure (expertise as well as analytical and processing facilities) to remain competitive.

Issues Affecting Research Directions

Canadian consumers are showing greater interest in the technologies used to grow food and manufacture food products. In particular, discussions about the use of biotechnology to produce genetically modified foods (GMOs), the use of antibiotics in animal feed, and reports of foodborne illness outbreaks attract substantial media attention and may have detrimental effects on consumers' confidence in the safety of the Canadian food supply. Recent World Trade Organization meetings highlight the importance of these issues for Canadian farmers and producers, who are losing some trade markets in countries opposed to GMOs and who face difficult decisions about what to plant to ensure their crops can be sold in domestic and global markets. Announcements by large food manufacturers, such as McCain's, that they will no longer use foods with GMOs have also put farmers, other producers and manufacturers in the difficult position of trying to predict consumer response to their products. More research into consumers' perceptions of the risks and benefits of new technologies, and the factors that create resistance to new technologies ("technological stigma"), is needed.

Ironically, while there is evidence of some consumer mistrust of new food technologies, the market for value-added products is expected to show rapid growth. Pending changes in the Food and Drug Act and labelling requirements, food products claiming to enhance health and reduce risk factors for disease are soon expected on Canadian markets. An aging but health-conscious population is expected to create a huge market for these nutraceuticals and functional foods.

A University of Guelph researcher recently attended a major nutraceutical and functional food meeting in The Hague where the European perspective on functional foods and nutraceuticals was

extensively addressed by presenters from business/academia/government sources. Figures were presented indicating that up to 50% of the food-related research budgets from government sources in Europe would be allocated to functional foods and nutraceuticals to ensure the international competitiveness of European products now and in the future. Canada lags behind the U.S., Japan and other countries in developing these food products, and more research on nutraceutical extraction and processing techniques and their effects on functional activity in animal models and humans, is needed. This research has the potential to create exciting new products and markets for Ontario-grown foods.

Food safety is central to industry's competitiveness in international trade. *Salmonella* in poultry, *Hepatitis A* in strawberries, and *E. coli,* hormones and BSE in beef are recent examples of food safety problems that have substantially affected trade, and in some cases have ruined businesses and damaged national economies. The World Trade Organization requires each country's food safety measures to be based on risk assessment to ensure that countries establish food safety requirements that are scientifically sound and to provide a means for determining equivalent levels of public health protection between countries. The Codex Alimentarius Commission, which establishes international food safety standards, is now developing principles for using risk assessment in establishing such standards.

In addition to trade implications, foodborne illness has economic impacts in terms of health and lost productivity. To estimate the current impact of foodborne disease in Ontario, data have been compiled in the following tables for the four foodborne diseases which are considered to have the most impact, in terms of incidence, cost and publicity. The first table includes the number of reported cases in Canada and Ontario based on Health Canada statistics for the most recent year available (1997). However, it is generally accepted that reported cases for foodborne diseases underestimate the total number of incidences. To estimate the total number of cases, information published by the American Academy of Microbiology was used (Doores 1998 http://www.asmusa.org/acasrc/pdfs/Foodsafetyreport.pdf). The estimated number of cases for Canada is based on population ratio relative to the US (30 million:300 million). A more recent report by Mead *et al.* (1999. Emerging Infectious Diseases 5: 607-625) confirms the US numbers shown in the table below.

The report of the American Academy of Microbiology also estimates costs associated with foodborne illness. The data based on a "labor market approach" were used to calculate estimated cost for Canada and Ontario. It was assumed that cost would be reduced proportional to population size with Canada having 1/10 and Ontario 1/30 of the US population. Based on this analysis, food safety is clearly important in terms of economic costs (lost productivity and health care) and access to export markets for Ontario food products.

Incidence of the four most frequent foodborne diseases in Ontario, Canada, and the USA

Bacteria	Cases reported in 1997*		Estimated cases per year (based on population ratio)	
	Ontario	Canada	Canada	USA**
Campylobacter	5,253	13,544	110,000 - 700,000	1,100,000 - 7,000,000
Listeria	36	47	93 - 177	928 - 1,767
Salmonella	2,626	6,015	69,600 - 384,000	696,000 - 3,840,000
Verotoxigenic *E. coli* (incl. *E. coli* O157:H7)	423	1,273	1,600 - 3,200	16,000 - 32,000
Total	8,338	20,879	181,300 - 1,087,400	1,812,900 - 10,873,800

*Health Canada statistics (http://www.hc-sc.gc.ca/hpb/lcdc/webmap/index.html)
** http://www.asmusa.org/acasrc/pdfs/Foodsafetyreport.pdf

Estimated cost for the four most frequent foodborne diseases in Ontario, Canada, and the USA

Bacteria	USA (billion US $)	Canada (billion US $)	Ontario (billion US $)
Campylobacter	1.6 - 10.1	0.16 - 1.01	0.05 - 0.33
Listeria	1.3 - 2.4	0.13 - 0.24	0.04 - 0.08
Salmonella	4.8 - 12.3	0.48 - 1.23	0.16 - 0.41
Verotoxigenic *E. coli* (incl. *E. coli* O157:H7)	0.3 - 0.7	0.03 - 0.07	0.01 - 0.02
Total	8 - 25.5	0.8 - 2.55	0.26 - 0.84

FOOD RESEARCH PROGRAM (2000-2004)

The Food Research Program has been developed to effectively use resources within the University of Guelph, including clusters funded recently by the Canadian Foundation for Innovation and Ontario Innovation Trust, as well as collaborating organizations (e.g. Agriculture and Agri-Food Canada, Health Canada, Canadian Food Inspection Agency, Guelph Food Technology Centre) to address research priorities of the Ontario Agricultural Services Coordinating Committee (OASCC). Research needs identified through the Food Industry Competitiveness Branch of OMAFRA (as reported in the OFPRSC 1999 Strategic Report for 2000 - 2004) and the Canada Committee on Food, a committee of the Canadian Agri-Food Research Council (CARC) have also been considered.

Collaborations

The OMAFRA-University of Guelph Food Research Program is associated with a wide spectrum of agri-food research activities. Although some research activities take place within individual laboratories or departments, there are a growing number of collaborations across units, across disciplines and across the university borders with provincial and federal government units as well as the Guelph Food Technology Centre. Some collaborations have developed in response to strategic government funding programs such as the Canadian Foundation for Innovation and the Ontario Innovation Trust.

CRIFS

The Canadian Research Institute for Food Safety (CRIFS) was created as the result of an $8 million grant from federal and provincial governments and industry awarded in June 1999. This grant will allow acquisition of a building to house the CRIFS initiative, renovation of laboratory space within the building, construction of a level 3 containment facility and the purchase of state-of-the-art equipment. Presently, there are more than 50 research scientists from several disciplines involved in CRIFS, making it one of the largest centres of its kind in North America. The researchers are affiliated with a number of UofG departments (including Animal and Poultry Science, Engineering, Food Science, Laboratory Services Division, Mathematics and Statistics, Microbiology, Pathobiology, Plant Agriculture, and Population Medicine), with federal government agencies (Agriculture and Agri-Food Canada and Health Canada), and with the Ontario Ministry of Agriculture, Food and Rural Affairs. Thus, CRIFS is uniquely placed to conduct research and training on microbial food safety as they relate to all aspects of the food chain.

CFSM

The Centre for Food and Soft Materials (CFSM) was created as the result of a $7.2 million grant from the federal and provincial governments and industry awarded in June 1999. The grant has allowed for the renovation of laboratory space in the Food Science Building, and acquisition of state of the art analytical and processing/packaging equipment. The CFSM brings together internationally renowned expertise in food and soft materials research spanning 18 different research groups (approximately 125 researchers, 6 departments and 3 colleges). The objective of

the Centre is to address structure-function relationships, from molecular to macroscopic scales, of foods, polymers and biopolymers, biological membranes and bacterial surfaces. The broad range of expertise and analytic techniques available within the Centre provides an ideal facility for industrial collaborations . Strong ties with corresponding industrial support already exists. Additional links between Centre researchers and industrial partners are being developed by the Laboratory Services Division of the University of Guelph and the Guelph Food Technology Centre.

CRI

The Consumer Research Institute (CRI), a facility for Food Safety Communications Research, has been established to strengthen the consumer-food links that already exist at the University of Guelph and to bridge the gap between social and physical sciences related to food. Scientists from Consumer Studies, Family Relations and Applied Nutrition, Food Science, Psychology, Plant Agriculture and Agricultural Economics will study consumer concerns and perceptions of the safety of Canadian foods, the factors that influence food selection and preparation practices, and the effectiveness of various types of communication strategies. The CRI also has links with other researchers in Canada known for their expertise in studying consumer attitudes towards foods, and with the Food Policy Institute in England, which has had extensive experience studying consumer confidence in the British food supply and the media influences on public perceptions.

The CRI will communicate information based on the best-available science and deliver those messages in a consistent and timely manner using a variety of mechanisms. This evidence-based science and economic evaluation can then be used by consumers, producers, industry and governments to develop Canadian and international food polices on an integrated basis (i.e. policies that integrate public perception with science-based advice and deliver that message in a consumer-friendly and meaningful way).

HNRU

The Human Nutraceuticals Research Unit (HNRU) has a special interest in research directed towards value-added novel foods, nutraceutical supplements or herbal supplements that offer health promotion as well as disease prevention and management in humans. There are 15 faculty members affiliated with HNRU as well as a scientific advisory committee which includes members external to the University of Guelph. Individual HNRU members have over 20 years of combined human trial experience with nutraceuticals and functional foods. The HNRU is available to the food and natural health product industry, in Canada and elsewhere, to evaluate products in controlled human studies for potential claims in the area of health enhancement and/or modification of risk factors in healthy individuals with respect to chronic disease.

GFTC

The Guelph Food Technology Centre (GFTC) is a technology-based company providing confidential food technology services on a fee-for-service basis to the food, health and agri-food industries and related sectors. GFTC offers the following services: product development; applied research; training and quality systems and pilot plant services. Many faculty associated with the

Food Program work collaboratively with GFTC staff on a variety of strategic industry problems as well as a variety of training courses. The GFTC has employed undergraduate students at various levels: co-op and summer students, B.Sc. and graduate students.

AAFC

In 1998, the Food Group from the Centre for Food and Animal Research moved from Ottawa to Guelph to become part of the Southern Crop Protection and Food Research Centre. The Food Research Program consists of 45 professional staff with three of the Research Scientists serving as Adjunct Professors in the Department of Food Science (Drs. Woods, McKellar and Cui). Research staff work on four food-related areas (see below) and work collaboratively with faculty in various departments (e.g., Food Science, Human Biology and Nutritional Science, Pathobiology, School of Engineering) thus enhancing the research capabilities of the Food program. The objectives of the four research areas are:

1. Functional Foods and Nutraceuticals: To identify, characterize, and determine the bioavailability and mode of action of minor functional components in plant and animal foods that promote health and reduce the risk of chronic diseases and to develop nutraceuticals and functional foods through value-added processes.
2. Functionality and Structures: To investigate the polysaccharide composition and physicochemical characteristics of selected cereal grains that relate to milling and processing performance, the textural quality of the finished product and the health benefits associated with consumption of these materials.
3. Food Preservation Technologies: To ensure the microbiological quality and safety of the Canadian food supply by developing economically and environmentally sound preservation systems for the enhancement of quality and safety of fresh and minimally processed fruits and vegetables, juices, milk, meat, poultry, and egg products.
4. Molecular and Cell Biology: To control human pathogens in food and livestock by developing and applying molecular methods for the isolation, characterization, identification, enumeration and monitoring of microorganisms, including human food-borne pathogens, probiotic bacteria and (bacterio)phages.

Collaborations within OMAFRA-University of Guelph Research Program

Clearly there are many points where production-side research in the Animal and Plant Programs is closely linked to food products and processing research. As an example, the research to effectively transfer DHA from animal feed to milk, is being extended by a Food Program project to evaluate physical and chemical characteristics of DHA milk as they affect products such as cheese. Interactions also occur in the other direction when research in the Food Program provides guidance to breeders on characteristics that would enhance the value on Ontario-grown crops. Although there are no active projects at present in the Environment and Natural Resources Program, there has been research related to environmental impact of food processing operations (e.g. dairy wastes) in the past.

A complete list of food-related active projects in other programs within the OMAFRA-University of Guelph Enhanced Partnership is included in Appendix 2.

Research Scientists Involved in the Food Program

Name	Location	Research Area/Expertise
Barbut, S.	Food Science, U of G	- meat science, poultry products technology, microbiology
Bettger, W.J.	Human Biology & Nutritional Sciences, U of G	- trace mineral nutrition, effects of dietary trace minerals on biomembranes
Chu, G.	HRIO	- controlled atmosphere storage
Davidson, V.J.	School of Engineering, U of G	- food engineering, fuzzy mathematics, decision-support system
Forbes, E.	Kemptville College	- food analysis & ingredient functionality
Goff, D.	Food Science, U of G	- dairy processing, physical chemistry of dairy products & frozen foods
Goldman, S.	Chemistry, U of G	- thermodynamics, supercritical fluid extraction
Griffiths, M.	Food Science, U of G	- microbiology, food safety
Holub, B.	Human Biology & Nutritional Sciences, U of G	- omega-3 fatty acids & *trans* fatty acids on cardiovascular health, membrane phospholipids in cellular responses, dietary management of renal disease
Kakuda, Y.	Food Science, U of G	- chemistry of food lipids and milk proteins; lipid oxidation; confectionary products, analytical techniques
Lencki, R.	Food Science, U of G	- food engineering, process economics, effluent treatment, extraction of food materials, bioreactor optimization
Marangoni, A.G.	Food Science, U of G	- fats and oils; non-aqueous lipase enzymology and interfacial behaviour; complexity and chaos

Name	Location	Research Area/Expertise
Mittal, G.	School of Engineering, U of G	- modeling of transport processes & product quality during cooking, pasteurization by pulsed electric fields
Odumeru, J.	Lab Services Division, U of Guelph	- molecular and cultural methods for detection and identification of microorganisms in food; pathogenic mechanisms of foodborne pathoegns
Paliyath, G.	Food Science, U of G	- biochemistry & molecular biology of fruits and vegetables; antioxidants and antioxidant enzymes
Schraft, H.	Food Science, U of G	- microbial biofilms; epidemiological typing of microorganisms, molecular methods for detection of foodborne microorganisms
Stiver, W.	School of Engineering, U of G	- environmental & biological applications for supercritical fluids, thermodynamics
Swatland, H.	Food Science, U of G	- meat quality, muscle growth, electronic systems for measuring food quality and intercellular enzyme activity
Woodward, W.	Human Biology & Nutritional Sciences, U of G	- immunodepression associated with wasting protein-energy malnutrition
Yada, R.	Food Science, U of G	- protein structure-function relationships, food-related enzymes, postharvest physiology and processing

FOOD RESEARCH PROGRAM (2000-2004) OBJECTIVES AND GOALS

Food Quality and Safety

Objective 1: Ensure safety and improve quality of Ontario food products.

To ensure that Ontario food products maintain their high quality standards in terms of microbial safety as well as sensory and nutritional factors while addressing the concerns of producers, processors and consumers, research efforts are directed to achieving four goals.

Goal 1.1 Develop analytical methods to assess quality parameters in foods (including sensory, microbial safety and nutritional factors).

Producers and processors are interested in rapid detection methods to identify and enumerate foodborne pathogens and spoilage organisms. Rapid detection protocols are important tools for the verification of HACCP plans. Rapid methods also allow processors to ensure that a given production lot is free of specified contaminants without unduly extending warehousing times. Detection methods, at the molecular level, are important in improving understanding of microbial growth and survival within complex food matrices. This research is necessary in order to design effective intervention strategies (Goal 1.4).

Foodborne pathogens, such as *Campylobacter*, *Salmonella enterica*, *Listeria monocytogenes* and *E. coli* are primary targets for methods development. These methods will include genetic approaches, such as the application of the polymerase chain reaction (PCR) and novel culture-based procedures, such as the application of impedance technology. Rapid detection methods for the presence of spoilage organisms, such as psychrotrophs in finished products, will be useful for processors committed to maintaining high microbiological quality of their products.

Goal 1.2 : Improve risk analysis in food systems that are relevant to Ontario food processors.

Risk analysis is a process that is increasingly used by the World Trade Organization to evaluate and control risks associated with food production, distribution and consumption. It includes three components: risk assessment, risk management and risk communication.

Risk assessment includes:

- hazard analysis and characterization (identification of the agent, disease or adverse health outcome),
- exposure assessment (frequency of disease, number of people exposed to risk, potential for growth or survival of agent in food) , and
- risk characterization (estimation of risk, number of cases and severity of outcome).

Risk assessment currently applies statistical methods to describe uncertainties associated with the data used in the models, e.g. to account for variability in pathogen growth in a food matrix. However statistical methods do not adequately describe all types of uncertainty. Fuzzy sets and the calculus of fuzzy logic are useful for uncertainty arising from experts' opinions or judgements as well as for uncertainty arising at preliminary stages of risk assessment, when limited quantitative information is available.

Another important step to improve current risk assessment models is the reduction of uncertainty associated with potential risk for food contamination and pathogen survival or growth. This requires better understanding of the effects of micro-environments within food matrices on microbial growth and survival. Improved knowledge in these areas leads to more effective intervention strategies (Goal 1.4).

Risk communication is an important aspect of any risk analysis system, but effectiveness of different communication strategies is poorly understood. There is a need for research that crosses the social and biological sciences in order to understand the psychological basis of consumers' perceptions of risks and technologies.

Goal 1.3 Improve the understanding of relationships between molecular structures and functions of food components related to quality (sensory, microbial safety and nutritional factors).

The production, storage and distribution of high quality food products requires better understanding of the molecular structure-function relationships of components within the food system as well as the micro-organisms which may be associated with these foods. Using sophisticated analytical techniques, researchers can analyse molecular changes in plant and animal tissues as well as formulated products and relate these changes to food quality in terms of microbial safety, sensory and nutritional factors.

Improved understanding will allow processors to more efficiently utilize and process components in existing agricultural resources as well as to identify potential value-added components (e.g. new functional food ingredients, nutritional supplements or food ingredients and marketed with claims of enhancing health and preventing disease). The knowledge is also important in developing new agricultural resources (e.g. new plant cultivars, enriched animal products)

Goal 1.4 Identify intervention strategies that can be applied at any level of the food chain to improve food quality (sensory, microbial safety, nutritional attributes).

Intervention strategies (e.g. changes in management practices, changes in processing procedures, or development of novel processing approaches) are central to any successful quality improvement. The fundamental knowledge developed through Goal 1.3 will be used to identify potential intervention strategies. For example, better understanding of how micro-organisms

interact with food components will be used to develop strategies to extend shelf-life while ensuring safety.

Value-Added Products

Objective 2: Develop value-added components in Ontario-grown food products.

Recently, scientists have demonstrated that the consumption of certain foods can have specific health benefits beyond providing essential nutrients, energy and pleasurable sensations. This discovery has revolutionized the field of nutritional sciences (now called nutritional and nutraceutical sciences) and is beginning to have a major impact on the food and agricultural industries in Canada.

- "Functional foods" are defined by Health Canada as foods that have a traditional food form and provide specific health benefits.
- "Nutraceuticals" are defined as foods that have a non-traditional food form (pills, potions, elixirs etc.) and provide specific health benefits.

Functional foods and nutraceuticals deliver health-protectant chemical ingredients. Functional foods and nutraceuticals enhance human performance by optimizing developmental processes and/or reducing the risk for chronic degenerative diseases.

Goal 2.1 Identify and develop health-protectant components in Ontario-grown foods.

There are many potential sources of health-protectant components in Ontario agri-food resources, including

- phytochemicals with nutraceutical potential in Ontario-grown fruits and vegetables,
- protein components in eggs,
- protein and lipid components in oilseeds such as soybeans and canola,
- lipid fractions of milkfat, and
- omega-3 enriched dairy products.

Research activities under this goal include isolation of functional components in foods produced in Ontario, analysis of the effects of extraction techniques and processing on the stability and bioavailability of functional components and development of new functional foods and nutraceuticals.

Goal 2.2 Characterize functionality and clinical efficacy of nutraceuticals by human and nutritional studies

Laboratory studies are necessary to determine the physiological/biochemical mechanisms by which health-protectant components in functional foods and nutraceuticals affect human tissues. In addition, human trials must be conducted to determine the safe intake range and the health effects of the health protectant chemicals consumed as part of functional foods and nutraceuticals.

Innovative Technologies, Processes and Systems

Objective 3: Design innovative technologies to manufacture traditional and new food products.

Research activities under this objective focus on developing food manufacturing technologies that are acceptable in terms of sustainability, competitiveness and consumer values. Process design research includes scale-up from laboratory procedures as well as evaluation of process economics at each stage of scale-up.

Goal 3.1 Develop appropriate technologies to extract and stabilize value-added components from Ontario agricultural resources as well as manufacturing waste streams.

In the program, this includes technologies to extract valuable components from unprocessed agricultural materials, recovery of components from manufacturing waste streams, and stabilization of functional components. Extraction technologies include the use of novel solvents such as supercritical carbon dioxide as well as innovative combinations of enzymes and fractionation methods. Process design requires teams of food scientists and engineers since it is critical that separation and stabilization do not degrade functionality. Also it is important to incorporate economic analysis at preliminary design stages. Otherwise, recovery costs may reduce the "value added" to a minimal or negative value.

Goal 3.2 Improve existing and develop new technologies for food preservation.

Food preservation includes post-harvest stabilization and large-scale storage as well as innovative packaging systems to maintain quality and extend shelf life of food products. The design of complete food packaging systems requires integration of post-harvest physiology, preservation methods, microbiology and packaging materials science. Research will focus on packaging performance relative to food quality requirements (including safety and sensory quality) as well as integrated preservation and packaging technologies (e.g. modified atmosphere environments). Post-harvest research will also focus on understanding and controlling metabolic processes that occur during storage. Fundamental knowledge of postharvest physiology in fruits and vegetables will allow for effective management of storage conditions and/or development of treatments to extend shelf life.

PROJECTS IN FOOD PROGRAM (APRIL, 2000)

Project #	Title
24380	Value-added products from milkfat
24510	Nutraceuticals in human health & nutrition
24520	Improving structure & properties of fruits, vegetables & processed products by regulating activities of undesirable & detrimental reactions
24540	Prediction of changes in chip colour and determination of factors regulating low-temperature sweetening in commercial storage of potatoes
24560	Structure & functional properties of anti-freeze proteins isolated from Ontario winter wheat
24570	Protein-polysaccharide interactions in frozen systems: effect on ice recrystallization in frozen foods
24580	Development of Ontario-grown blueberries yielding value-added nutraceuticals & functional foods
24710	Improving safety of fermented meat products
24820	Fuzzy & statistical techniques for risk assessment
24830	Process development for better quality fried foods
24880	Immune-supportive functional food activity of flaxseed & canola oils
24940	Pre-treatment technology development for the non-solvent extraction of lycopene
25050	Value-added product recovery using supercritical fluids
25130	Application of impedance technology for Salmonella detection on beef & poultry
25140	Developing new gas transfer systems for Modified Atmosphere Packaging
25256	Physical and chemical properties of fat globules and casein micelles in milk naturally supplemented with DHA
25270	A systems approach to the evaluation and extension of ready-to-use packaged vegetables
25280	Role of biofilm formation in the persistence of Listeria monocytogenes in food processing environments
25400	The development of sphingolipids from milk and soybeans as functional food ingredients
25560	Characterization of foodborne pathogens using the RiboPrinter
25564	Improvement of fluid holding capacity of meat
25561	Evaluation of different Modified Atmosphere Packaging systems for shelf life extension of fresh fruits and vegetables
23090	Preparation of food samples for chemical analysis in health Canada's "The Market Basket Study".
21380	Controlled atmosphere storage and modified atmosphere packaging of fruits
17300	Extracting aromas and flavours using supercritical carbon dioxide

COMMUNICATION PLAN

The Food Program is committed to presenting research findings at multiple levels. The communication plan targets interactions with the scientific community, agri-food processors, policy developers as well as consumers. Examples of typical communication activities are included in the section TECHNOLOGY TRANSFER and many of these same activities will continue:

- publications in peer-reviewed journals,
- presentations at technical meetings and conferences,
- graduate student theses,
- articles in industry publications and popular press,
- participation in industry-targeted short courses offered by the GFTC,
- meetings with producers groups and industry associations,
- interactions with NRC's network of Industry Technology Advisors (ITA),
- membership on OASCC committees and sub-committees,
- participation in community events such as the Royal Winter Fair and College Royal.

In addition, specific efforts are planned:

- Follow-up success of 1999 "**Food Science at Work**" conference with a biennial event. The purpose of the conference is to showcase innovative food research conducted by the University of Guelph and its partners.
- **Improve Food Program web page**. The web page will link to the OASIS database so that current projects and key information (project leader, executive summary) will be available to the public. In addition, there will be links between the OMAFRA-UofG Food Program and other clusters on campus (Food Science, CRIFS, CFSM, CRI, HNRU). This will also be a means to improve communication with on-campus units (such as the GFTC) so that activities such as short courses can be coordinated.
- Work with the Office of Research SPARK program (Students Promoting Awareness of Research Knowledge) to develop popular press articles as well as a *Research* magazine dedicated to highlights from the Food Program.
- Encourage researchers to **expand their communication efforts** with relevant **industry associations** (e.g. Ontario Food Processors Association, Public Health units).
- Link with CRI efforts to improve communications with consumers.

APPENDIX 1 - ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ARIO	Agricultural Research Institute of Ontario
CA	Controlled atmosphere
CARC	Canadian Agri-Food Research Council
CCF	Canada Committee on Food
CFI	Canadian Foundation for Innovation
CFSM	Centre for Food and Soft Materials
CRI	Consumer Research Institute
CRIFS	Canadian Research Institute for Food Safety
FTE	Full Time Equivalent
GFTC	Guelph Food Technology Centre
HACCP	Hazard Analysis and Critical Control Points
HNRU	Human Nutraceuticals Research Unit
HRIO	Horticultural Research Institute of Ontario
IRAP	Industrial Research Assistance Program
MAP	Modified atmosphere packaging
NSERC	Natural Sciences and Engineering Research Council
OASCC	Ontario Agricultural Services Coordinating Committee
OSFERSC	Ontario Agricultural and Food Engineering Research and Services Committee
OFPRSC	Ontario Food Processing Research and Services Committee
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OIT	Ontario Innovation Trust
ORDCF	Ontario Research and Development Challenge Fund
PCR	Polymerase Chain Reaction
PSE	Pale, soft, exudative (pork)

APPENDIX 2 – ACTIVE PROJECTS IN PLANT AND ANIMAL PROGRAMS WHICH ARE RELATED TO FOOD PROGRAM

ANIMAL PROGRAM PROJECTS WITH A FOOD COMPONENT

Project #	Leader	Collaborating Faculty	Title
Aquaculture			
20870	Kakuda, Y.	Moccia, R.	Quality Improvement and Shelf-Life Extension of Fish Fillets and Deboned Fish Meat from Three Aquaculture Species
20870	Kakuda, Y.	see below	Quality Improvement and Shelf-Life Extension of Fish Fillets and Deboned Fish Meat from Three Aquaculture Species
23180	Moccia, R.	see below	Replacement of synthetic carotenoid pigments with lycopene extracts for trout and salmon pigmentation
23180	Moccia, R.	Kakuda, Y.	Replacement of synthetic carotenoid pigments with lycopene extracts for trout and salmon pigmentation
25330	KAKUDA, Y.	(co-leader)	Effects of food grade acidulants on the microbial quality of fish fillets from two aquaculture species.
25330	MOCCIA, R.	(co-leader)	Effects of food grade acidulants on the microbial quality of fish fillets from two aquaculture species.
Beef			
15310	BUCHANAN-SMITH, J.		Nutrition and management effects on growth and meat quality in cattle.
20590	Black, W.		Development of Simple, Efficient and Inexpensive Methods for Detecting Antibacterial Residues in Carcasses of Slaughtered Animals
20790	McEwen, S.		Prevention of Microbial and Chemical Contamination of Beef
23300	Wilton, J.		The use of real-time ultrasound to predict carcass quality traits in breeding heifers
23550	Mandell, I.		Altering Acid-Base Balance to Improve Beef Tenderness
25520	Gyles, C.		Biocontrol of Escherichia coli 0157:H7 and Salmonella typhimurium DT104 using Phage Therapy.
Dairy			
16290	MCBRIDE, B.		Nutrition to promote health of the cow and to produce healthful dairy products.
16350	KELTON, D.	see below	Enhancing milk quality and udder health in Ontario through a sentinel dairy network.
16350	KELTON, D.	Lissemore, K.	Enhancing milk quality and udder health in Ontario through a sentinel dairy network.
16350	KELTON, D.	Leslie, K.	Enhancing milk quality and udder health in Ontario through a sentinel dairy network.
Poultry			
22580	Leeson, S.		Manipulating the composition of poultry meat and eggs relative to issues of food safety and improved human nutrition
23040	Barbut, S.		Enhancing the safety and quality of poultry products

Project #	Leader	Collaborating Faculty	Title
23630	Gibbins, A.		Value-added products in egg white through transgenic technology
25370	HAYES, A.	see below	Avian mucosal lectins and resistance to Salmonella and E. coli.
25370	HAYES, A.	Hunter, D. B.	Avian mucosal lectins and resistance to Salmonella and E. coli.
Sheep			
16180	WILTON, J.	Gibson, J.	Breeding strategies and genetic evaluations for carcass merit for progeny of OLIBS ewes.
24670	Wilton, J.		Genetic improvement of carcass merit and maternal characteristics of OLIBS animals.
Pork			
15390	SQUIRES, J.		Major genes affecting pork production and meat quality.
16640	OSBORNE, V.	Mandell, I.	Supranutritional administration of nutrients which improve the quality and stability of fresh and cooked pork and poultry.
16640	OSBORNE, V.	see below	Supranutritional administration of nutrients which improve the quality and stability of fresh and cooked pork and poultry.
22520	Gibson, J.		Development of a Resource Population of Pigs for Detection of Quantitative Trait Loci Controlling Growth, Carcass Composition and Meat Quality
22900	McEwen, S.		Prevention of Microbial Contamination of Pork
23170	Phillips, J.	Forsberg, C.	Application of transgenic methodology in swine for reduced environmental impact and enhanced carcass quality
23170	Phillips, J.	see below	Application of transgenic methodology in swine for reduced environmental impact and enhanced carcass quality
23210	Buhr, M.		Manipulating sperm lipids to improve boar sperm storage
24950	DEWEY, C.	see below	Alternatives to raising pigs without antibiotics.
24950	DEWEY, C.	Fan, M.	Alternatives to raising pigs without antibiotics.
24950	DEWEY, C.	Hodgin, D.	Alternatives to raising pigs without antibiotics.

PLANT PROGRAM PROJECTS WITH A FOOD COMPONENT

PLANT PROGRAM - UofG/OMAFRA Research Program Projects

Proj #	Sub-Program	Leader	Title
20890	Field Crops	Ablett, G.	Development and Evaluation of Improved Soybean Cultivars and Germplasm
20940	Field Crops	Brown, R.	Quality-Based Control System for Corn Drying
21060	Field Crops	Hunt	Wheat Breeding and Management Research
21090	Field Crops	Kott, L.	Continued Improvement of High Quality Canola Adapted for Ontario
21150	Field Crops	Michaels, T.	Genetic Improvement of Common Bean
21170	Field Crops	Pauls, P.	Applications of Molecular Biology and Tissue Culture to Crop Improvement
21220	Field Crops	Schaafsma, A.	Corn Quality Research to Support the Expansion of Food Grade Corn Culture in Ontario, and Integrated Pest Management Strategies for Field Crops
22120	Field Crops	Rajcan, I.	Soybean Cultivar Development for Improved Efficiency of Production and Marketability
22130	Field Crops	Lee, E.	Corn Breeding and Genetics
23230	Field Crops	Pauls, P.	Biotechnological improvement of Ontario corn
21380	Horticulture	Chu, G.	Controlled Atmosphere Storage and Modified Atmosphere Packaging of Fruits
21390	Horticulture	Cline, J.	Orchard Management and Physiology of Tree Fruit Crops, Particularly Apple
21400	Horticulture	Dale, A.	Breeding and Management of Berry Crops
21410	Horticulture	Derkacz, M	Improvement of Fruit Production through Improvement of Soil Fertility and Fruit Tree Nutrition
21430	Horticulture	Dixon, M.	Management and Measurement Techniques for Greenhouse Nutrient Recycling
21440	Horticulture	To be filled immediately - GHV	Greenhouse Vegetable Research Program
21450	Horticulture	Eady, F.	Breeding of Cherries and Plums and Management of Cherries, Pears and Plums
21460	Horticulture	Fisher, K.	Vineyard Management for Vinifera Cultivars in Ontario
21470	Horticulture	Fisher, K.	Variety Development/Evaluation and Production Management for Efficiency and Profitability in Juice, Wine and Table Grapes in Ontario
21490	Horticulture	Grodzinski, B.	Integrated Control Systems for Root and Aerial Environments of Greenhouses Crops: Management of Allelochemicals and Micro-Organisms in Closed-Cycle Hydroponic Systems
21500	Horticulture	Grodzinski, B.	Genetic Engineering and Testing for Shade Tolerance and Rapid Growth Traits in Selected Greenhouse Ornamental and Vegetable Crops
21520	Horticulture	Hughes, B.	Horticultural Crop Management and Cultivar Selection in Northern Ontario
21590	Horticulture	Loewen, S.	Breeding and Cultivar Evaluation of Processing Tomatoes
21620	Horticulture	McDonald, M	Muck Vegetable Crop Management Studies
21630	Horticulture	McKeown, A.	Vegetable and Non-Traditional Crop Management and Physiology
21640	Horticulture	Miles, N.	Improvement of Economic Potential for the Production of Peaches and Nectarines
21700	Horticulture	O'Sullivan, J.	Crop Management Studies for Processing Cucumbers and Other Vegetables
21720	Horticulture	Rinker, D.	Production and Pest Management of Mushrooms: Research and Extension
21730	Horticulture	Saxena, P.	Development of New Technologies for Improvement of Phytomedicinal Crops
21740	Horticulture	Skog, L.	Improvement of Postharvest Quality of Ontario-grown Fruit and Vegetables
21780	Horticulture	Sullivan, A.	Berry Crop Breeding and Genetic Transformation
21790	Horticulture	Sullivan, A.	Berry Crop Management
21800	Horticulture	Wolyn, D.	Development of Improved Asparagus Germplasm
21810	Horticulture	Zandstra, J.	Cultural Management and Cultivar Evaluation of Fresh Market and Processing Vegetables
21820	Horticulture	Zandstra, J.	Cultural Management and Cultivar Evaluation of Fruit Crops
22110	Horticulture	Murr, D.	Improvement of Postharvest Quality of Fruits, Vegetables and Ornamentals by Application of Stress Management Strategies
22140	Horticulture	Sullivan, A.	Evaluation of Potato Varieties and Breeding Selections in Ontario
22440	Other	Powell, D.	Implementation and evaluation of on-farm food safety programs for the Ontario fruit and vegetable sector

Proj #	Sub-Program	Leader	Title
21920	Pest Mgmt	McDonald, M	Crop Protection of Muck Vegetables
21930	Pest Mgmt	McFadden-Smith, W.	Integrated Pest Management of Fruit Crops
21940	Pest Mgmt	Nassuth, A.	Development and Optimization of PCR Assays for Pathogens of Ontario Horticultural Crops
21980	Pest Mgmt	Sears, M.	Ecology and Management of Insect pests in Field, Vegetable and Ornamental Crops
23110	Pest Mgmt	Hallett, R.	Control Strategies for Crucifer and Muck Vegetable Insect Pests